

Environmental Impact Study of Mountaintop Mining and Valley Fill Operations in West Virginia

Aquatic Impacts Study

July 16, 2002

Briefing for EIS Steering Committee

Overview of Briefing

- Aquatic Impacts Study
- ORD/NERL Involvement
- Biological Indices
- EIS Results
 - Fish
 - Macroinvertebrates
- Summary

Aquatic Impacts Study Objectives

- Is the biological condition of streams in areas with MTM/VF operations degraded compared to the condition of streams in un-mined areas?
- Are there “additive” biological impacts in streams where multiple fills are located?

Aquatic Impacts Study

- Region III initiated the aquatic impacts study to support the overall EIS
- Spring 1999 to Winter 2000
- Field collections
 - Fish
 - Macroinvertebrates
 - Habitat
 - Water chemistry

ORD/NERL Involvement

- Three reasons:
 - Region III was criticized for descriptive only analysis of macroinvertebrate data
 - Penn State/Region III presented fish data using an index calibrated for larger streams (OEPA)
 - Mining company monitoring data was not included in EIS

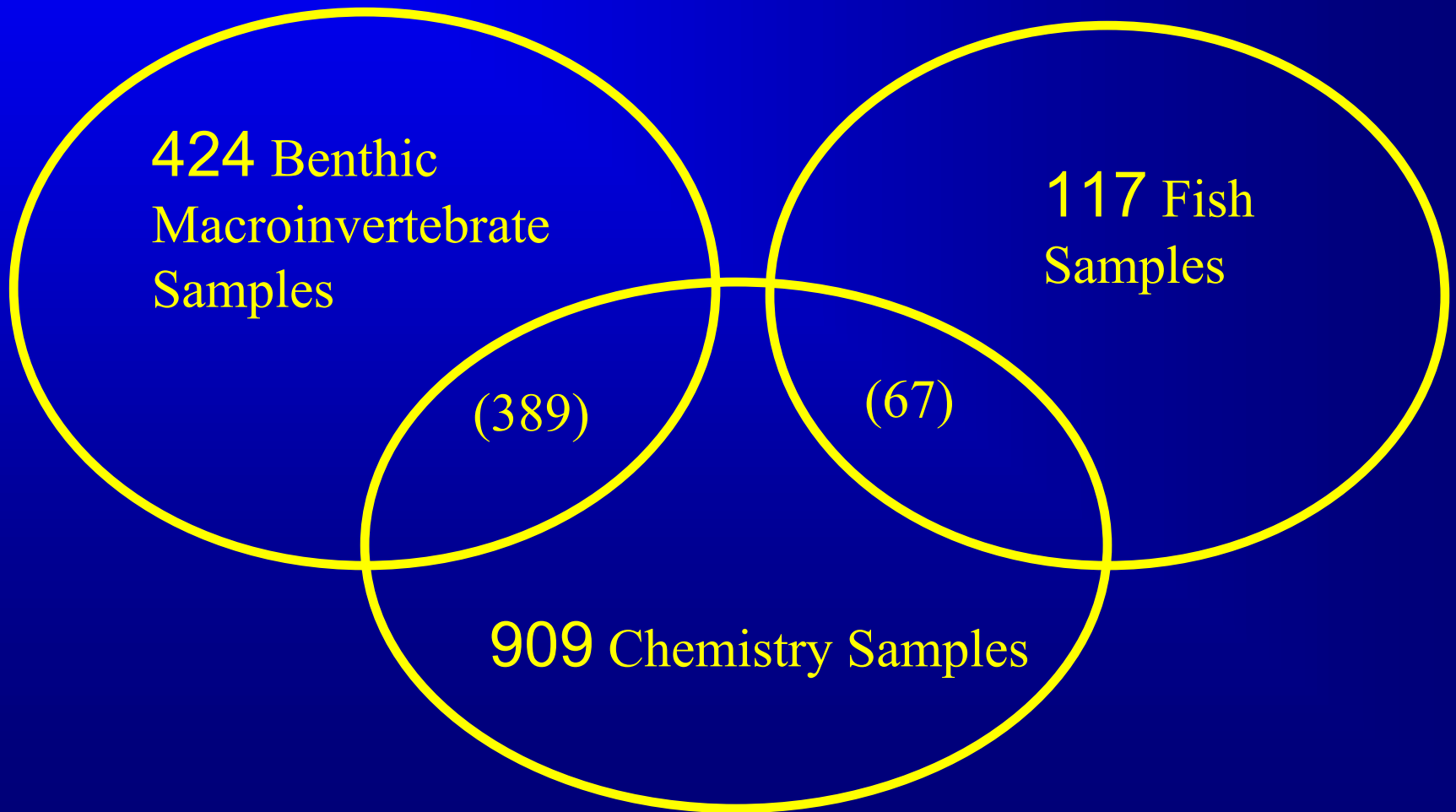
ORD/NERL Involvement

- Assembled database of Region III, Penn State and mining company data
- Analyzed fish and macroinvertebrate data separately to address study objectives
- Provide report to EIS steering committee for inclusion in the overall EIS

Mining Company Data

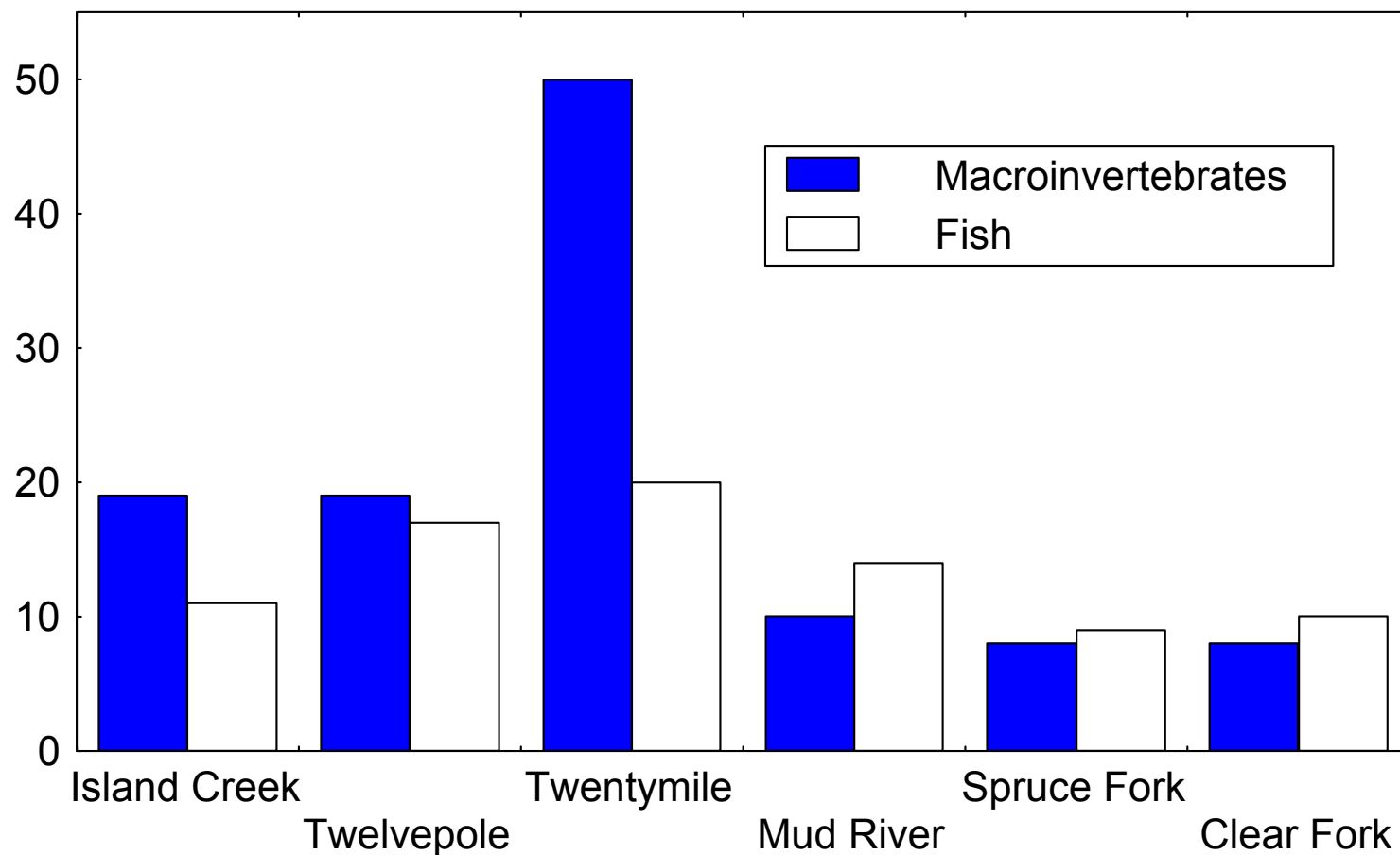
- Fish, macroinvertebrate, water chemistry, habitat and field chemistry
- Pen Coal, Arch, Massey, Fola
- Twentymile, Island Creek and Twelvepole

Sample Size



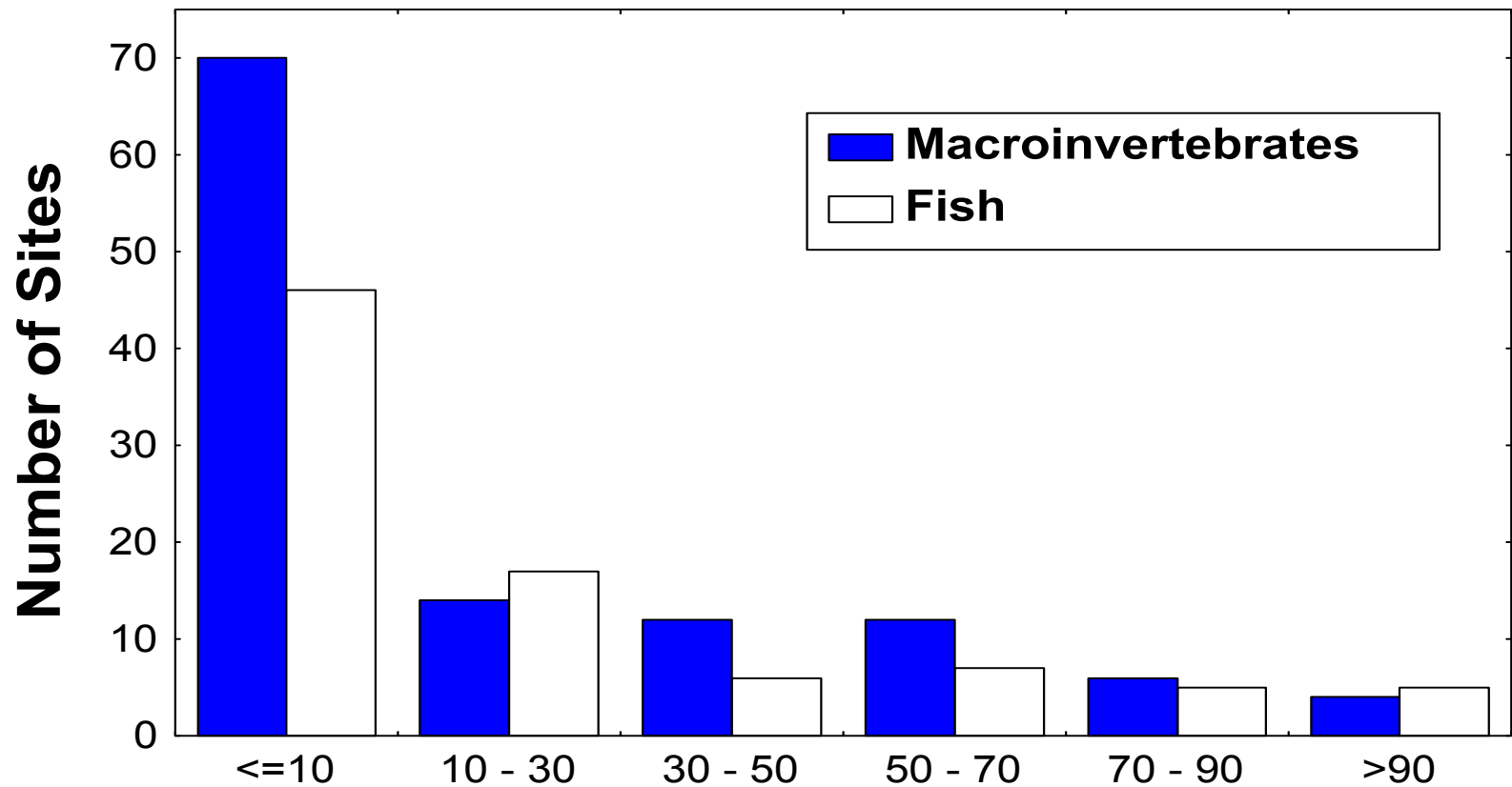
Sample Size By Watershed

Number of Sites



Sample Size

by Subwatershed Area (sq km)

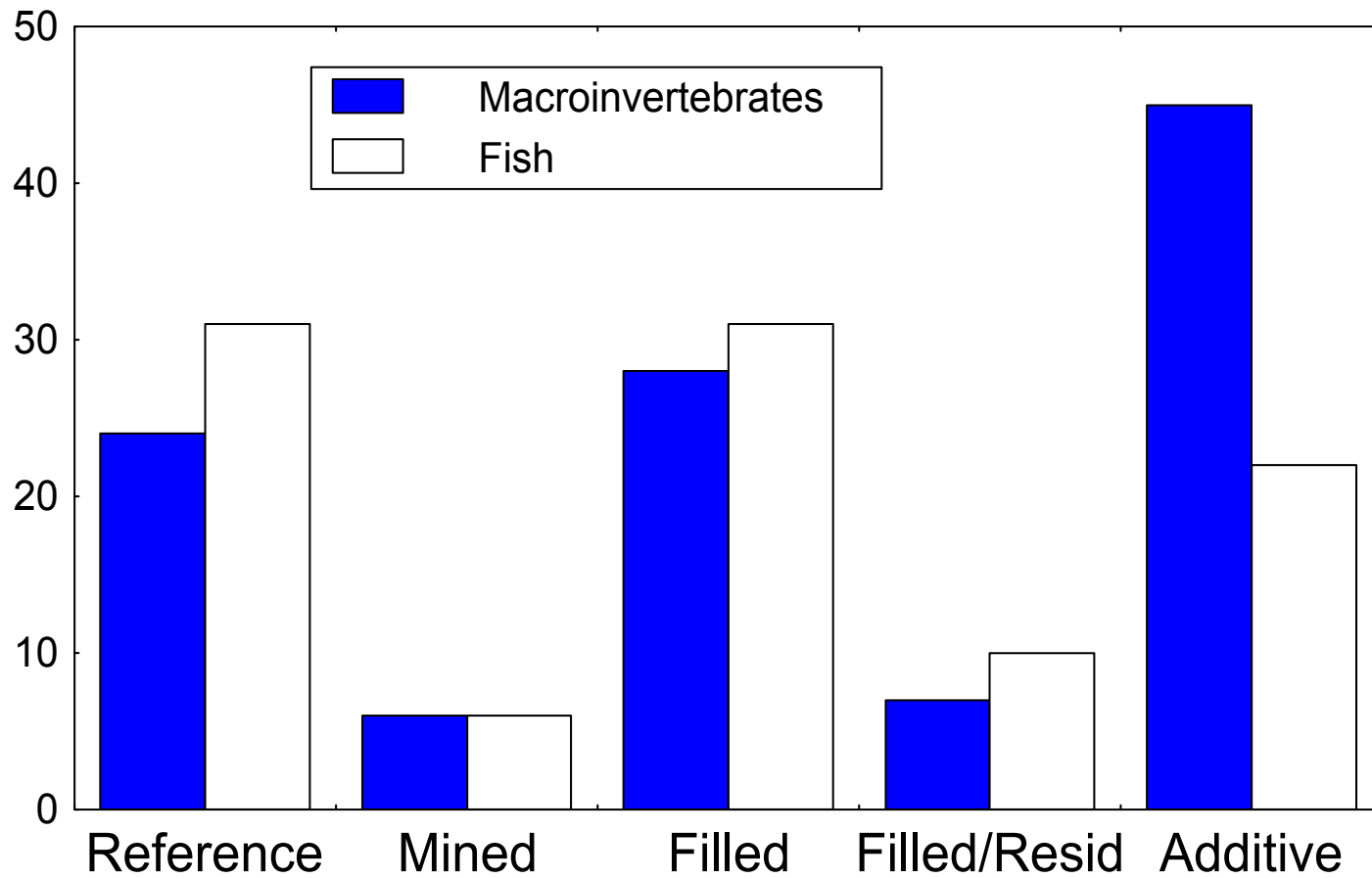


Site Classes

- Regional reference
- Unmined – no mining activity (EIS)
- Filled - one or more valley fills (EIS)
- Mined - mined by other methods (EIS)
- Filled/Residential – fills and residential land use (EIS)
- Additive – multiple sources

Sample Size By Site Type

Number of Sites



How should we assess biological condition?

- Biological indices:
 - Compare the diversity, composition, and functional organization of a stream community to those of natural streams in the region
 - Recommended in EPA Guidance
 - Biological Criteria: National Program Guidance for Surface Waters (EPA-440/5-90-004), April 1990
 - CALM: Consolidated Assessment and Listing Methodology
- As of 1995, 42 states are using biological indices to assess impacts to streams

Biological Indices for MTM/VF EIS (off-the-shelf)

- West Virginia Stream Condition Index (WVSCI) for invertebrates (Gerritsen et al. 2000)
- Mid-Atlantic Highlands IBI for fish (McCormick et al. 2001)

Aquatic Impacts Study Objectives Revisited

Is the biological condition of streams in areas with MTM/VF operations degraded compared to the condition of streams in un-mined areas?

- One-way analysis of variance to test for differences among all EIS classes ($\alpha = 0.05$)
- Least square means test to compare Unmined sites vs. Filled, Filled & Residence, and Mined sites ($\alpha = 0.01$)

Aquatic Impacts Study Objectives Revisited

Are there “additive” biological impacts in streams where multiple fills are located?

- Descriptive measures, Spearman correlations and linear regressions with stream mile along the main stem in two watersheds

Results of Fish Analysis

Fish IBI Metrics

- Differentiate between reference and stressed samples
- Represent different aspects of the community (taxonomic, trophic, reproductive, tolerance)
- Adjusted for watershed area

- ✓ Intolerant species
- ✓ Native minnow species
- ✓ Native benthic invertivore species
- ✓ % Sculpin individuals
- ✓ % Gravel spawning individuals
- ✓ % Piscivore/invertivore individuals
- ✓ % Macro-omnivore individuals
- ✓ % Tolerant individuals
- ✓ % Exotic individuals

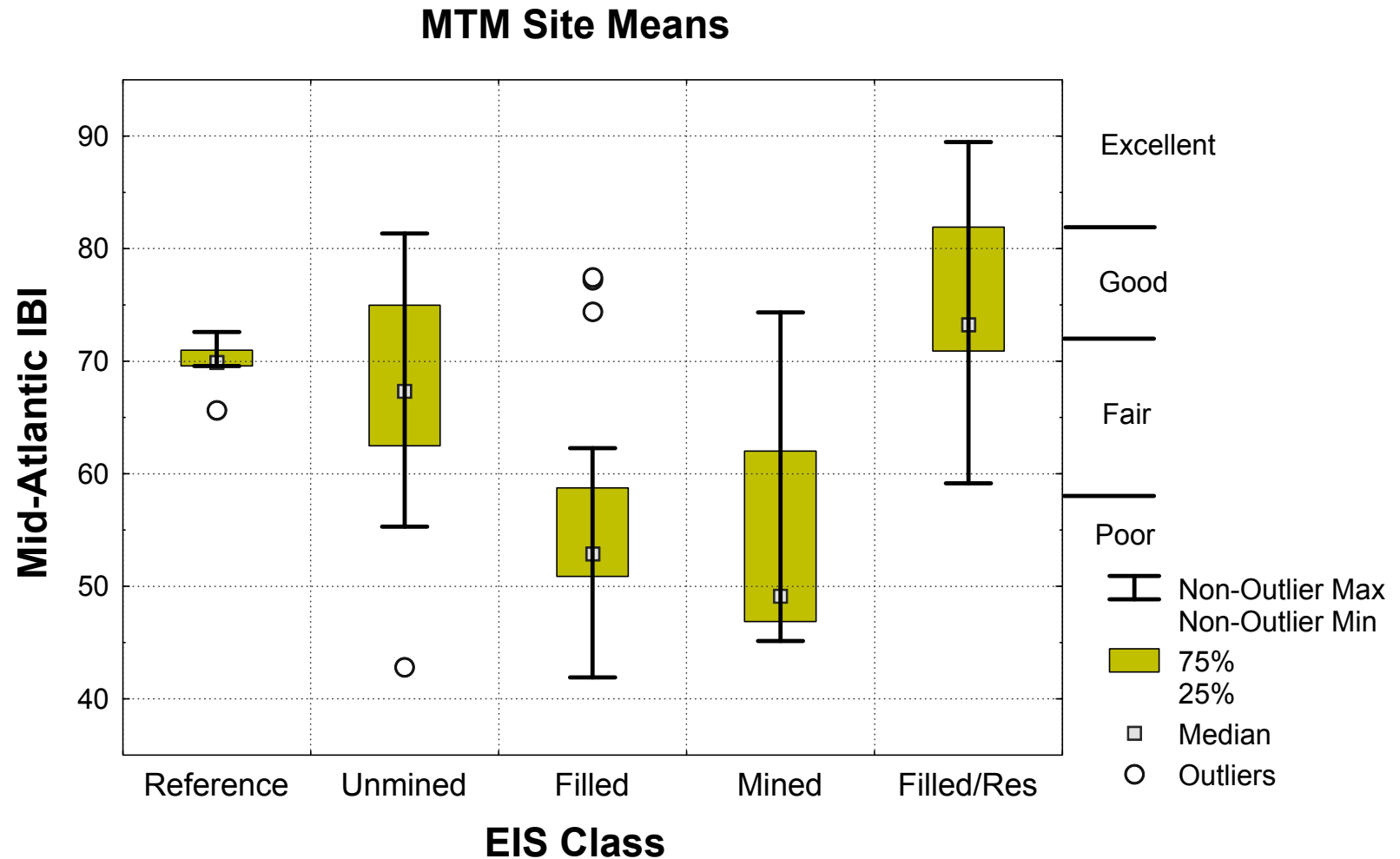


Analysis of Fish Data

- No one season had sufficient fish data for analysis.
- Site averages of the IBI and component metrics were primary analysis endpoints.

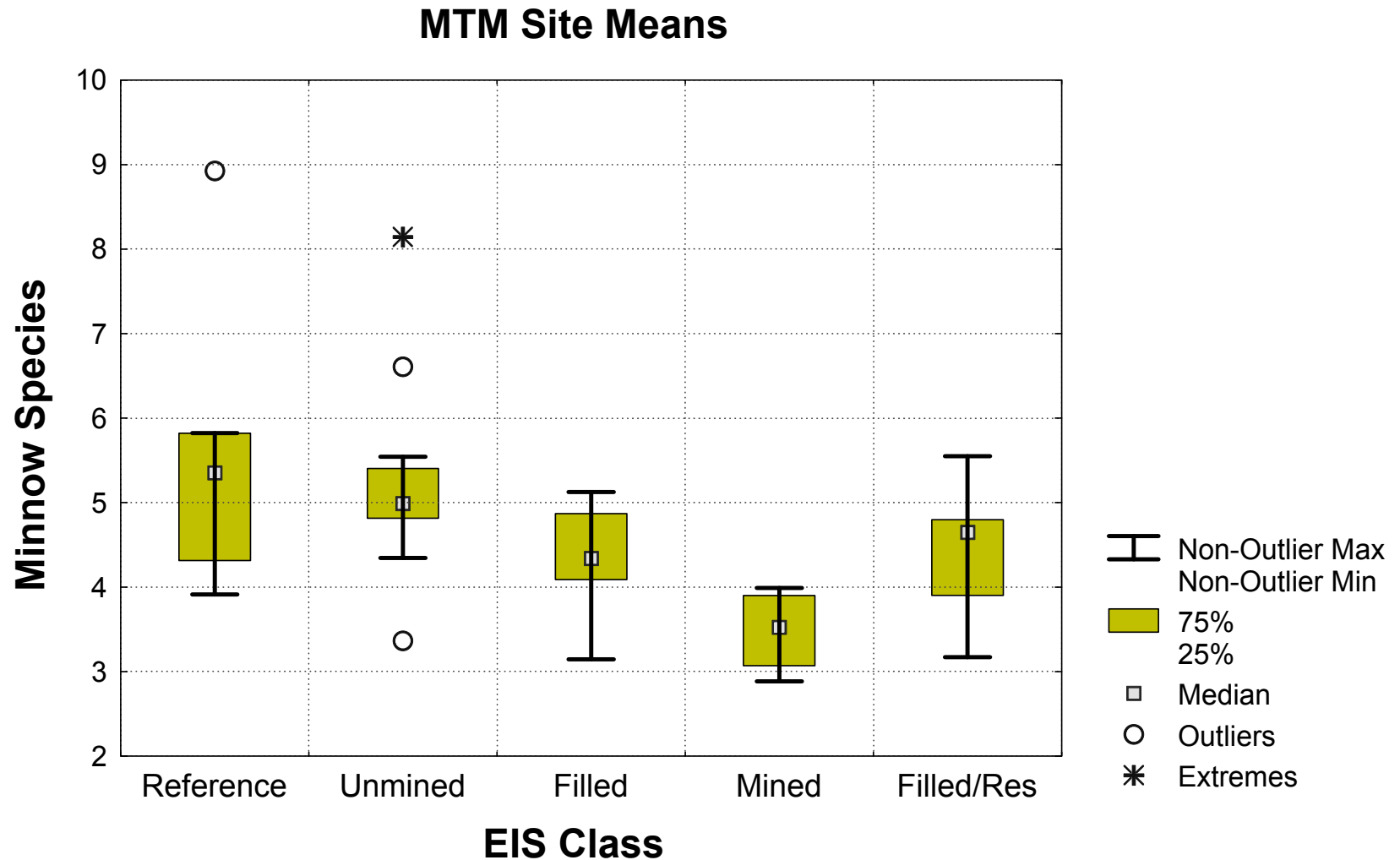
Mid-Atlantic IBI: Filled vs. Unmined

Unmined sites have higher biotic integrity than filled sites



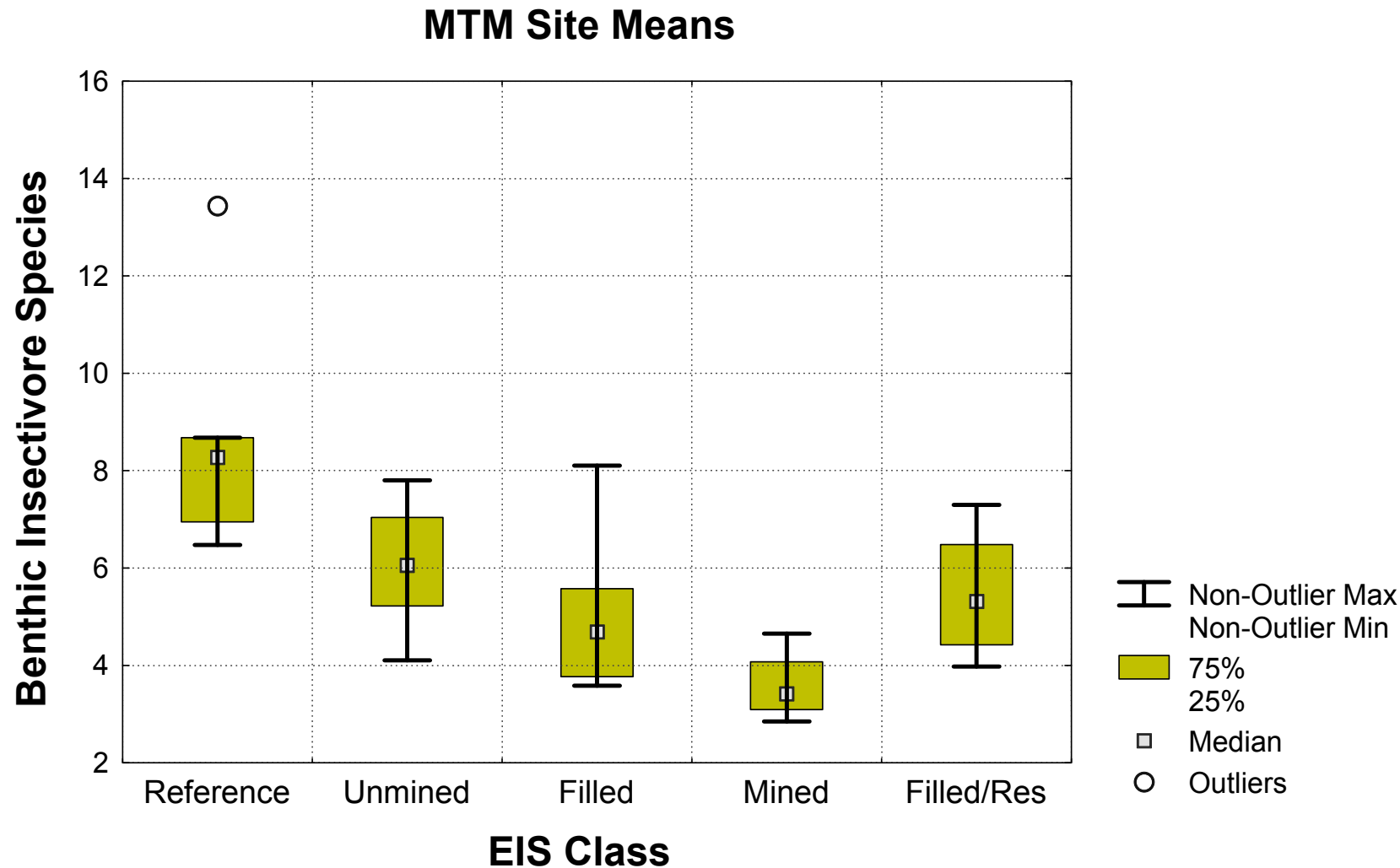
Minnow species: Filled vs. Unmined

Unmined sites have more minnow species than filled sites



Benthic Insectivore Species: Filled vs. Unmined

Unmined sites have more benthic insectivore species than filled sites



Fish Analysis Results: Comparison of EIS Classes

- Filled and Mined classes had lower IBI scores than Unmined
- IBI reduction in filled sites driven by loss of minnow species (Cyprinidae) and loss of benthic insectivore species
- IBI reduction not uniform: several Filled sites apparently unaffected
- *Filled/Residential the same or higher than Unmined*

Filled/Residential the same or higher than Unmined

- Subwatershed area may buffer/mitigate stressors
- Filled or Mined Sites $< 10 \text{ km}^2$
 - IBI nearly always Fair to Poor
- Filled or Mined Sites $> 20 \text{ km}^2$
 - IBI nearly always Good to Excellent
- Filled/Residential sites tend to have larger subwatershed areas

Fish Analysis Results: Additive Sites

- Two watersheds, Twelvepole Creek (mining + residential) and Twentymile Creek (mining only)
- No pattern in Twelvepole Creek; most observations in “Fair” range
- Twentymile Creek IBI in “Good” range to confluence of Peachorchard; in “Poor” range below Peachorchard

Water Quality Associations

- Small sites ($<10 \text{ km}^2$)
- Zinc, sodium, and sulfate negatively correlated with IBI score; all may be leachate from mine spoil

Rate Analysis Results

WVSCI Core Metrics

- Differentiate between reference and stressed samples
- Represent different aspects of the community (richness, composition, tolerance)

- ✓ Total Taxa
- ✓ EPT Taxa
- ✓ % EPT
- ✓ % Chironomidae
- ✓ % Top 2 Dominant Taxa
- ✓ Family HBI



Analysis of Macroinvertebrate Data

- Comparisons made for each of six seasons
- Only data from Twenty-mile Creek watershed available for last two seasons
- WVI, SCI, and component metrics were primary analysis endpoints

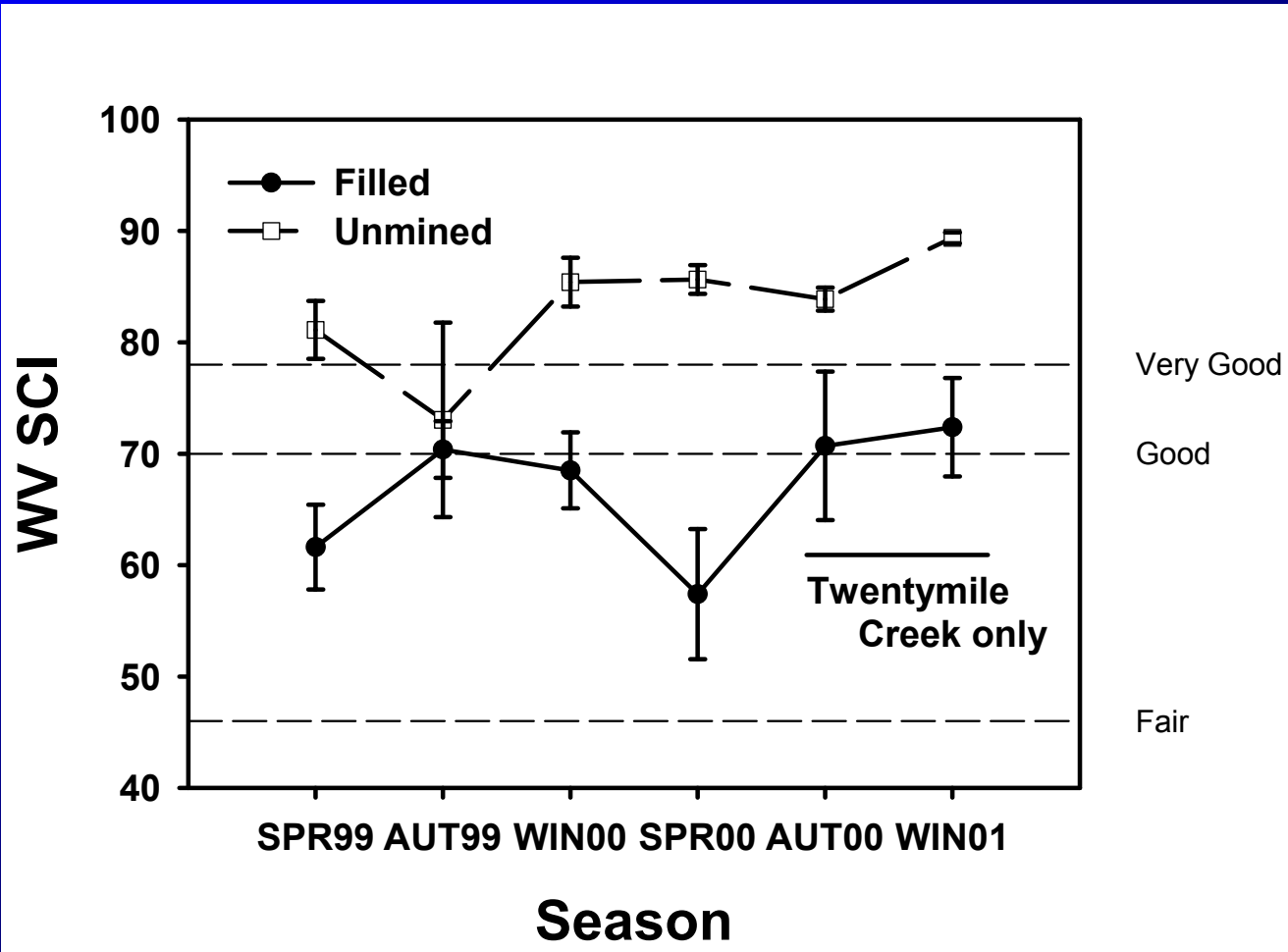
EIS Class Comparisons by Season: WV SCI

Season	P-value	Vs. Unmined Only
Spring 1999	<0.0001	Filled, Fill & Res.
Autumn 1999	0.0454	
Winter 2000	<0.0001	Filled, Fill & Res.
Spring 2000	0.0001	Filled, Fill & Res.
Autumn 2000*	0.1945	
Winter 2001*	0.0110	Filled

*Twentymile Creek only

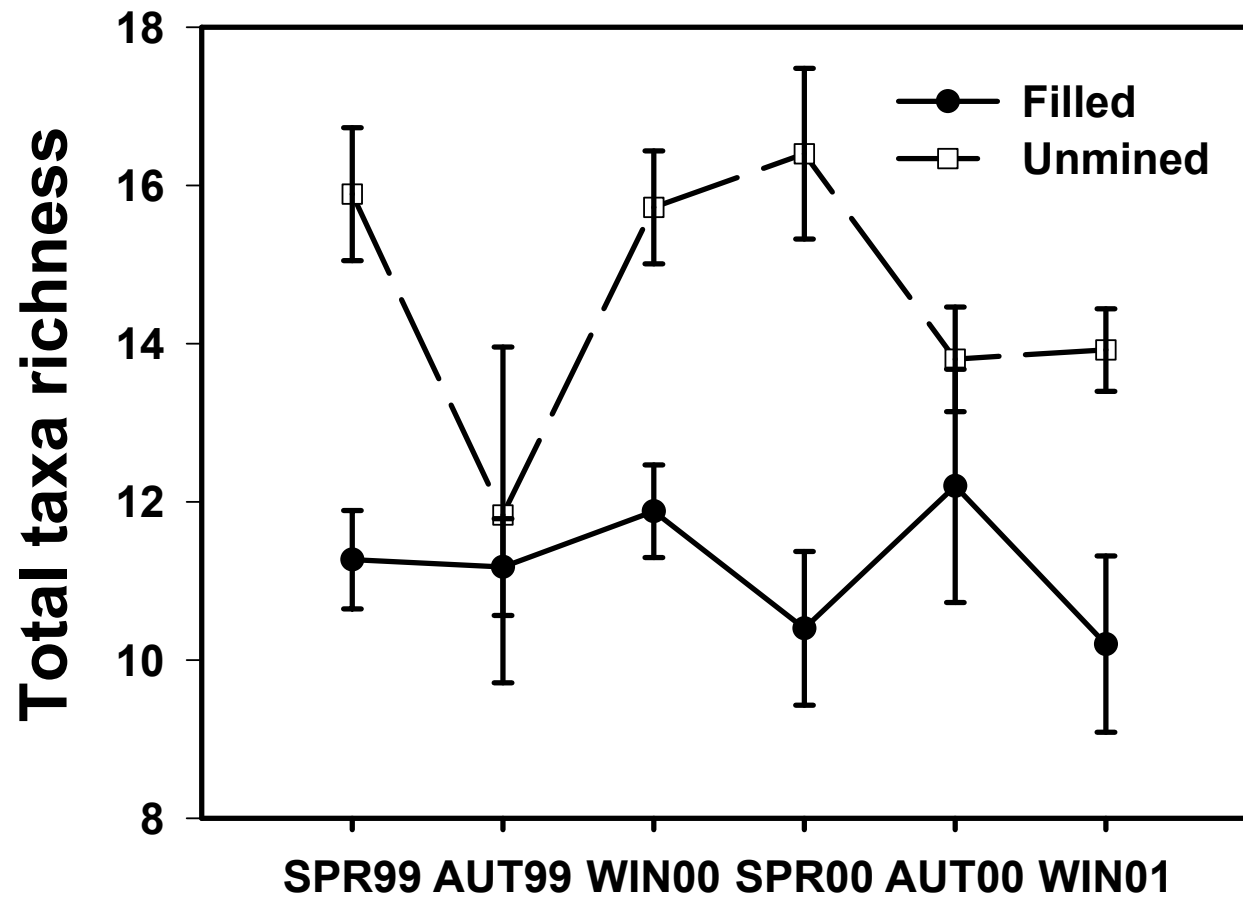
WV SCI: Filled vs. Unmined

Unmined sites have higher biotic integrity



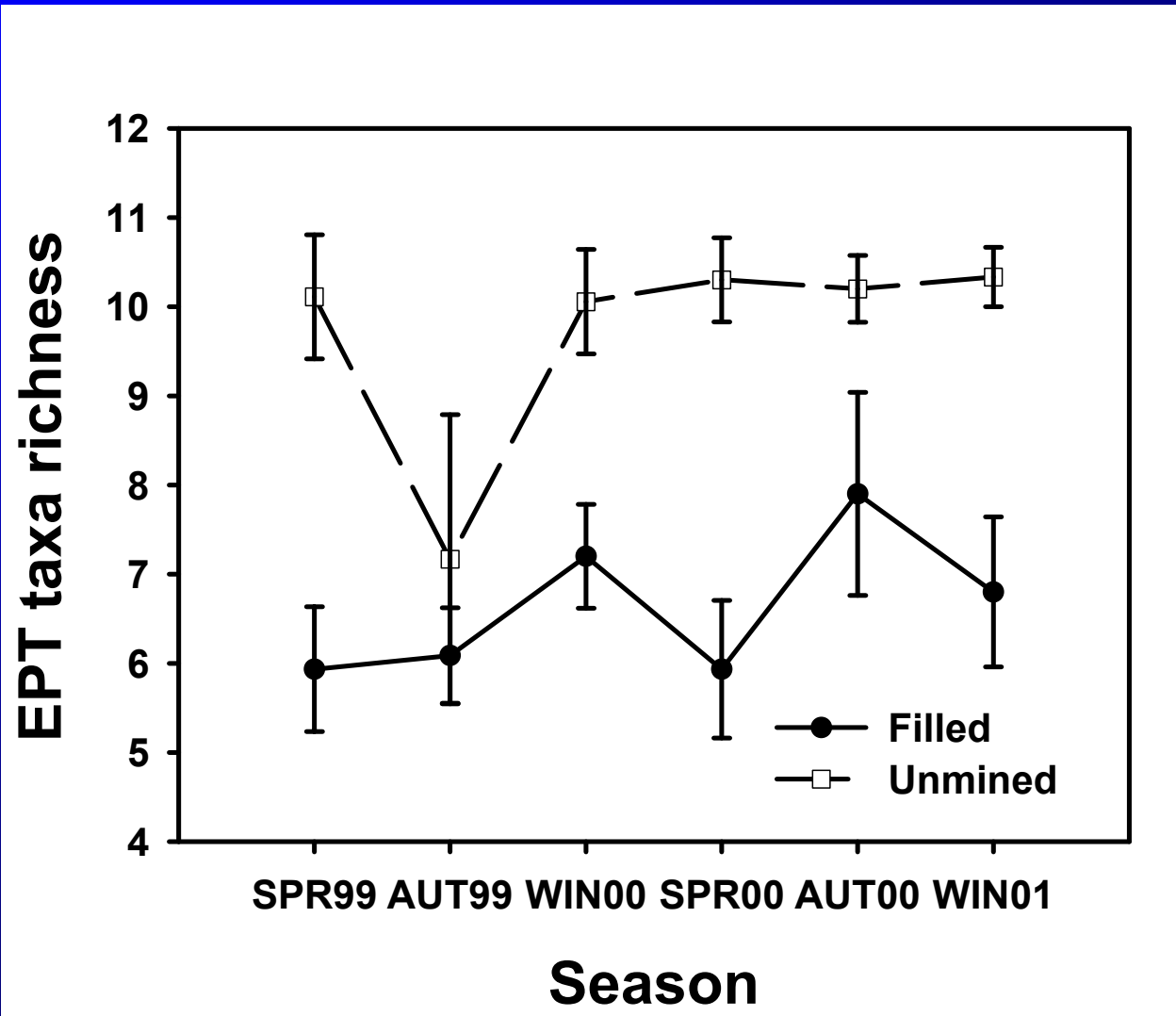
Total taxa richness: Filled vs. Unmined

Unmined sites have more taxa



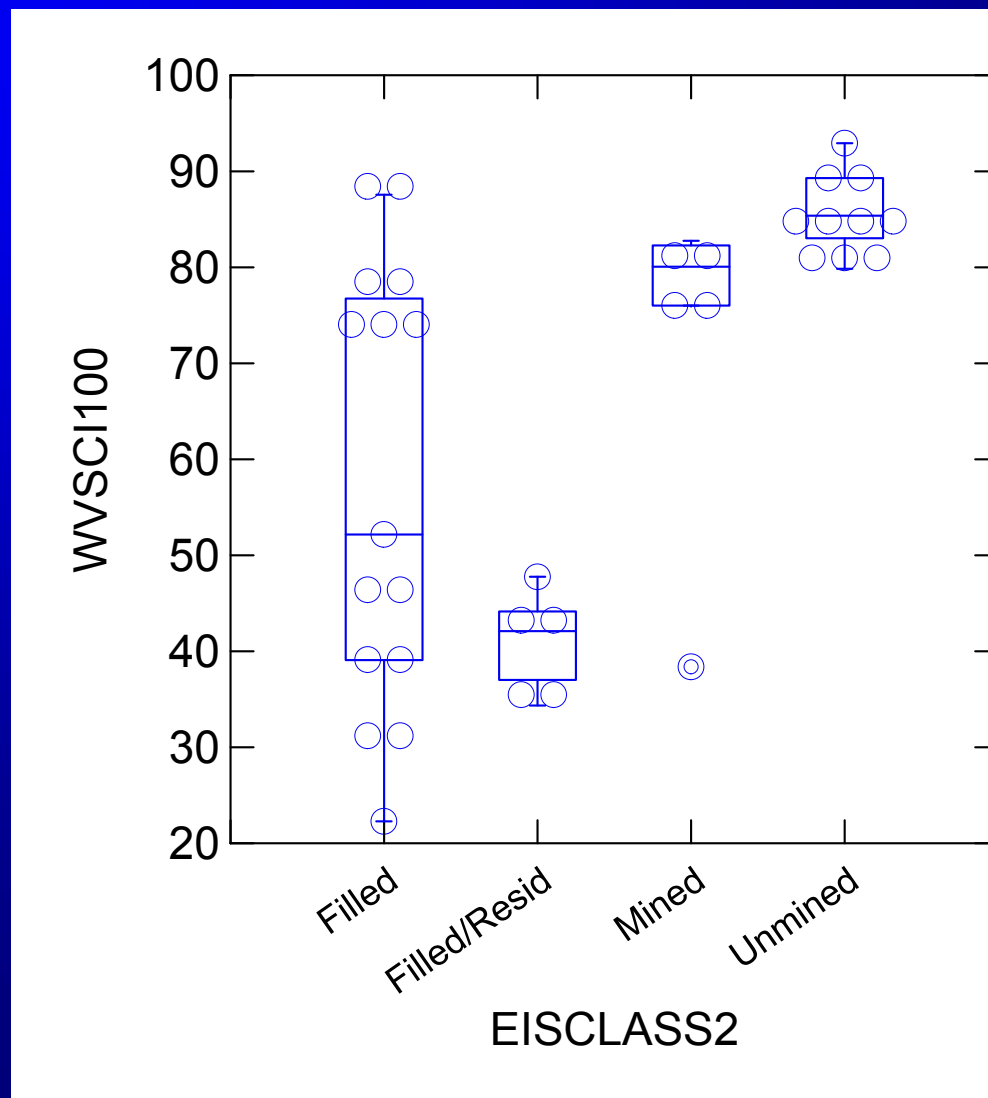
Sensitive taxa richness: Filled vs. Unmined

Unmined sites have more sensitive taxa



WV SCI Score Distribution by EIS Class

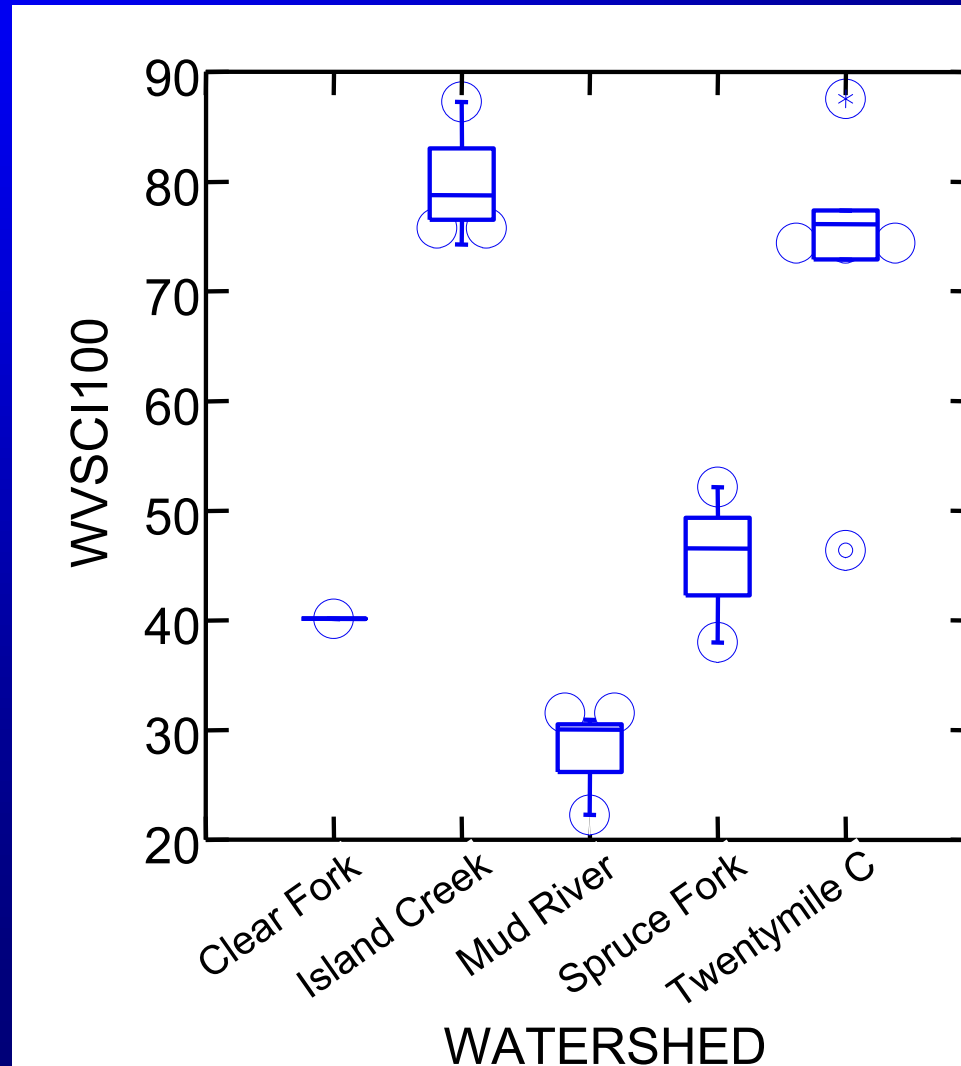
Note bi-modal distribution of Filled sites



Spring 2000

WV SCI Scores in Filled Sites

Bi-modality due to scores differing by watershed
Note the high scores in Twentymile Creek



Spring 2000

Macroinvertebrate Analysis Results: Comparison of EIS Classes

- Biological integrity based on macroinvertebrates is higher in Unmined sites than in Unmined sites
- Reduced biological integrity primarily a result of a loss of total and sensitive taxa in Filled sites
- Conditions in Filled sites varies by watershed
- Certain water quality parameters are negatively correlated with biological integrity

Macroinvertebrate Analysis Results: Additive Sites

- Examined sites along Twentymile Creek
- Samples collected Autumn 1999 to Winter 2001
- Impacts increased across seasons and upstream to downstream (17 km)
- Winter 2001: WV SCI decreased approximately 1 point for each stream km
- Space and time may be surrogates for increased mining activity in the watershed

Water Quality Associations

- Increased levels of ions are negatively correlated with the WV SCI
 - Conductivity
 - Total Dissolved Solids (TDS)
 - Ca, Mg, K, Na, Sulfate
- Increased levels of Se and Zn are negatively correlated with the WV SCI

Aquatic Impacts Study

Conclusions

- Biological integrity is impacted downstream of mining activity with fills
- Strongest associations are with water chemistry parameters
 - Zinc, sodium and sulfate correlated with both fish and macroinvertebrates
- Potential drivers of condition:
 - Mining practices and material handling
 - Geological factors associated with coal seams, including overburden

Data Gaps

- Additional data for Mud River, Spruce Fork, and Clear Fork
- Before-after time series data for fill and unmined sites

Data Gaps (cont.)

- Information on mining practices:
 - Size and age of fills
 - Proportion of subwatershed that is mined - the relative amount of subwatershed that is mined is greater in smaller subwatersheds than in larger subwatersheds
 - Material handling
 - Geological information on coal beds & overburden